F1-282

United States Department of the Interior

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F1-282

July 29, 1997

Ms. Kate Hansel
CALFED Bay-Delta Program
1416 Ninth Street, Suite 1155
Sacramento, CA 95814
fax: 916-654-9780

Dear Ms. Hansel:

It has come to my attention that there is an addition error in the budget table for a proposal that was submitted yesterday in response to the RFP for 1997 Category III funding. The proposal in question is titled: "Localization and Characterization of Mercury Sources in Water, Colloids, and Sediment in the Sacramento River between Bend Bridge and Colusa, the Cosumnes River, and the Feather-Yuba-Bear River System. The applicants are: Charles Alpers, Joseph Domagalski, Howard Taylor, Kavid Krabbenhoft, David Roth, and Jim Rytuba, all with the U.S. Geological Survey (USGS).

The error is that the "USGS in-kind" contribution for task 5 ($36,000) was not included in the "Totals, Tasks 1-5" section of the budget table (Table 1). This error affects the total project cost, but does not affect the amount requested from CALFED. Please make the following changes to the budget table and to the Executive Summary to correct this error:

1. (Table 1, last line, right-hand column) Change $180,000 to $216,000 to reflect the total "USGS-in kind" for tasks 1-5. (For your convenience, a revised version of Table 1 is attached.)
2. (Executive Summary, page 2, section e. "Budget Costs and Third Party Impacts") Please change this section to read as follows:
"Completion of all project objectives will cost $2,563,334. Funds requested from CALFED are in the amount of $2,257,334. The USGS will contribute $306,000 in matching funds and in-kind contributions. There will be no third party impacts."

Thank you very much for including this corrected information with our proposal. I apologize for any inconvenience this has caused.

Sincerely,

Charles N. Alpers, Research Chemist

attachment

Task 1	Red Bluff to Colusa mercury synoptic						
		Year 1 (Dec. 1998 through March, 1999)					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct costs)	Service Contracts	Material & Acquisition Contracts	Misc. & other Direct Costs	Total Cost
CALFED	1060	$34,660	$56,745	$0	$0	$23,700	$115,105
USGS Match	0	$0	$0				$0
Total - Task 1	1060	$34,660	$56,745	$0	$0	$23,700	$115,105
Task 2	Spatial and temporal variability in mercury and methyl mercury occurrence						
		Years 1&2 June 1998 through June 2000					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct costs)	Service Contracts	Material & Acquisition Contracts	Misc. & other Direct Costs	Total Cost
CALFED	7176	$208,088	$421,526	$0	$0	$250,772	$880,386
USGS Match	600	$18,000	$18,000				$36,000
USGS-in-kind	400	$18,000	$42,000			$24,000	$84,000
Total - Task 2	7776	$226,088	$439,526	$0	$0	$250,772	$1,000,386
Task 3	Examination of mercury and methylation in dredge tailings						
		Years 1&2 June 1998 through June 2000					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct costs)	Service Contracts	Material & Acquisition Contracts	Misc. & other Direct Costs	Total Cost
CALFED	4400	$117,600	$227,025	$0		$169,429	$514,054
USGS Match	300	$9,000	$9,000			$0	$18,000
USGS-in kind	400	$18,000	$23,000			$5,000	$46,000
Total - Task 3	0	$0	$0	$0	$0	$174,429	$578,054
Task 4	Mercury fractionation and speciation						
		Years 1&2 June 1998 through June 2000					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct costs)	Service Contracts	Material & Acquisition Contracts	Misc. & other Direct Costs	Total Cost
CALFED	4000	$118,400	$257,932			$154,258	$530,590
USGS Match	300	$9,000	$9,000			$0	$18,000
USGS-in kind	400	$18,000	$25,000			$7,000	$50,000
Total - Task 4	4700	$145,400	$291,932	$0	$0	$161,258	$598,590
Task 5	Report Writing						
		Year 3, October 2000 through September 2001					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct	Service Contracts	Material & Acquisition	Misc. & other	Total Cost
CALFED	2600	$84,600	$108,600			$24,000	$217,200
USGS Match	300	$9,000	$9,000			$0	$18,000
USGS-in kind	400	$18,000	$18,000			$0	$36,000
Total - Task 5	3300	$111,600	$135,600	$0	$0	$24,000	$271,200
Totals, Tasks 1-5							
CALFED	16636	$478,748	$963,228			$598,159	$2,257,334
USGS	1500	$45,000	$45,000				$90,000
USGS-in kind	800	$36,000	$48,000			$12,000	$216,000
Total Project Cost							$2,563,334

e. BUDGET COSTS AND THIRD PARTY IMPACTS: Completion of all project objectives will cost $2,563,334. Funds requested from CALFED are in the amount of $2,257,334. The USGS will contribute $306,000 in matching or in-kind contributions. There will be no third party impacts.

f. APPLICANT QUALIFICATIONS: Dr. Charlie Alpers has a Ph.D. in geochemistry from the University of California, Berkeley, and has been involved in numerous water quality investigations of trace element geochemistry in surface and ground water systems. Dr. Alpers has investigated the Penn Mine acid mine drainage system, has completed investigations of acid mine drainage from the Iron Mountain Superfund site, and is involved in characterizing the geochemistry of trace elements in the Sacramento River. Dr. Joseph Domagalski has a Ph.D. from the Johns Hopkins University and has been associated with the U.S. Geological Survey since 1988. He is Project Chief for the Sacramento River Basin National Water Quality Assessment (NAWQA) Program. His professional experience has included characterizations of trace metal chemistry in closed-basin lakes of the western United States and with the adaptation of NAWQA Program protocols or study design for trace metals, including mercury. Dr. Howard Taylor is a senior geochemist for the U.S. Geological Survey with over 25 years of experience with trace metal chemistry in large river systems throughout the United States. Dr. Taylor was a senior scientist involved with a study of trace metals in the Mississippi River system and has been providing the analytical chemistry support for a study of trace metal transport within the Sacramento River Basin. Dr. David Krabbenhoft is a senior hydrologist with the U.S. Geological Survey who operates a mercury and methyl mercury laboratory and who has been involved with detailed research projects on mercury speciation and methylation in several locations including the Florida Everglades. Dr. Jim Rytuba, a senior geologist with the Geologic Division of the USGS, is an internationally known expert on the geology and geochemistry of the types of mercury deposits located in the Coast Ranges. Dr. Rytuba has been extremely active in adapting classic and novel geologic and geochemical techniques for environmental characterization.

g. MONITORING AND DATA EVALUATION: This project will require the extensive collection of water quality and sediment samples and the collection of new data. Because of this extensive collection of new data, the first task of the project will be the preparation of a detailed quality assurance/quality control plan. The plan will be written by project scientists and submitted to a technical advisory committee for review, revision, and subsequent approval. Quarterly reports will be available on the data collected and on the results of the quality assurance monitoring.

h. LOCAL SUPPORT/COORDINATION WITH OTHER PROGRAMS/COMPATIBILITY WITH CALFED OBJECTIVES: This project has an extraordinary compatibility with other proposals currently being submitted to CALFED including the following: Integration of mercury studies and results on the San Francisco Bay-Delta System, Applicants: T.H. Suchanek and others; The role of upstream mercury loading and speciation on localized and downstream bioaccumulation: A regional assessment of sources and fates of mercury throughout the bay-delta watershed, Applicants: T.H. Suchanek, and others; The status of mercury as a stressor to habitats and species of the San Francisco-Bay delta ecosystem, Applicants: Mark Marvin-DiPasquale, and others; and, Mercury Fluxes in the Cache Creek Watershed: Characterization of mercury speciation and transport from mine wastes, mine drainage and natural sources, Applicants, Jim Rytuba, and others. It is anticipated that information and/or data collected in this program will be freely shared by applicants involved in these other programs.

F1-282

EXECUTIVE SUMMARY

a. PROJECT TITLE: Localization and Characterization of Mercury Sources in Water, Colloids and Sediment in the Sacramento River Between Bend Bridge and Colusa, the Cosumnes River, and the Feather-Yuba-Bear River System.

Applicant Name: U.S. Geological Survey (USGS), Applicants: Charles Alpers (USGS), Joseph Domagalski (USGS), Howard Taylor (USGS), David Krabbenhoft, David Roth (USGS), and Jim Rytuba (USGS)

b. PROJECT DESCRIPTION: The purpose of this project is to obtain detailed information on the sources of mercury and methyl mercury along a major reach of the Sacramento River and three large tributaries to the Sacramento River--the Yuba, Feather, and Bear Rivers-- and one major tributary to the Delta--the Cosumnes River. In each of these areas, anomalously high mercury concentrations have been determined by recent USGS investigations, but the sources of mercury remain unidentified. The project will provide detailed information on the forms of mercury transported in these rivers--by analysis of whole water, conventionally filtered water, ultra-filtered water, colloid concentrates, and bed sediments; and will also provide a characterization of the chemical speciation of solid-phase mercury in terms of the most abundant mineralogical forms or organic forms associated with the mercury and methyl mercury. Mercury speciation analysis will be of critical importance in determining the potential bioavailability of this material.

c. APPROACH/TASKS/SCHEDULE: The first task will determine likely or potential sources of mercury to the Sacramento River along a reach of the river between Red Bluff and Colusa. A second task will be to complete characterizations of the spatial and temporal variability of mercury and methyl mercury along the reach of the Sacramento River between Red Bluff and Freeport and along reaches of two tributaries--the Yuba and Feather Rivers. The third task will examine the role of dredge tailings, from historic gold mining operations, as a potential site of mercury methylation. Two sites will be selected at two different rivers for this assessment--the Bear River and the Cosumnes River. A fourth task is to complete detailed characterizations of the forms of mercury and methyl mercury transported during seasonal hydrologic flow conditions. The fifth task will be data evaluation, synthesis, and report writing. The first task will be completed during the rainy season of 1998 to 1999 (between December 1988 through April 1999, depending on when a suitable storm occurs). The second, third, and fourth tasks will begin June of 1998 and will continue for two years. The fifth task will begin in 1999 and be completed in 2001.

d. JUSTIFICATION FOR PROJECT AND FUNDING BY CALFED: Mercury is a serious water quality problem for the Sacramento River, the Delta, and San Francisco Bay. Because of this widespread distribution of mercury, every region of the Bay-Delta is affected by this contaminant and many of the Priority Habitats, such as seasonal and tidal wetlands, and Priority Species identified by CALFED, such as Green Sturgeon and Largemouth Bass, are impacted by mercury. Several California agencies have identified mercury as a contaminant of major concern to aquatic species and to humans. The formation of methylmercury in a variety of habitats is of primary ecological concern because of the uptake of this toxic contaminant by aquatic organisms and biomagnification upward in the food web, with fish commonly being highly contaminated. There are large gaps in the understanding of the sources of mercury to these waterways, the forms of the mercury being transported, and the speciation/bioavailability of the mercury. This investigation will form the basis of future management decisions on the most likely or candidate locations for remediation or environmental clean-up for mercury.

e. BUDGET COSTS AND THIRD PARTY IMPACTS: Completion of all project objectives will cost $2,527,334. The USGS will contribute $270,000 in matching or in-kind contributions. There will be no third party impacts.

f. APPLICANT QUALIFICATIONS: Dr. Charlie Alpers has a Ph.D. in geochemistry from the University of California, Berkeley, and has been involved in numerous water quality investigations of trace element geochemistry in surface and ground water systems. Dr. Alpers has investigated the Penn Mine acid mine drainage system, has completed investigations of acid mine drainage from the Iron Mountain Superfund site, and is involved in characterizing the geochemistry of trace elements in the Sacramento River. Dr. Joseph Domagalski has a Ph.D. from the Johns Hopkins University and has been associated with the U.S. Geological Survey since 1988. He is Project Chief for the Sacramento River Basin National Water Quality Assessment (NAWQA) Program. His professional experience has included characterizations of trace metal chemistry in closed-basin lakes of the western United States and with the adaptation of NAWQA Program protocols or study design for trace metals, including mercury. Dr. Howard Taylor is a senior geochemist for the U.S. Geological Survey with over 25 years of experience with trace metal chemistry in large river systems throughout the United States. Dr. Taylor was a senior scientist involved with a study of trace metals in the Mississippi River system and has been providing the analytical chemistry support for a study of trace metal transport within the Sacramento River Basin. Dr. David Krabbenhoft is a senior hydrologist with the U.S. Geological Survey who operates a mercury and methyl mercury laboratory and who has been involved with detailed research projects on mercury speciation and methylation in several locations including the Florida Everglades. Dr. Jim Rytuba, a senior geologist with the Geologic Division of the USGS, is an internationally known expert on the geology and geochemistry of the types of mercury deposits located in the Coast Ranges. Dr. Rytuba has been extremely active in adapting classic and novel geologic and geochemical techniques for environmental characterization.

g. MONITORING AND DATA EVALUATION: This project will require the extensive collection of water quality and sediment samples and the collection of new data. Because of this extensive collection of new data, the first task of the project will be the preparation of a detailed quality assurance/quality control plan. The plan will be written by project scientists and submitted to a technical advisory committee for review, revision, and subsequent approval. Quarterly reports will be available on the data collected and on the results of the quality assurance monitoring.

h. LOCAL SUPPORT/COORDINATION WITH OTHER PROGRAMS/COMPATIBILITY WITH CALFED OBJECTIVES: This project has an extraordinary compatibility with other proposals currently being submitted to CALFED including the following: Integration of mercury studies and results on the San Francisco Bay-Delta System, Applicants: T.H. Suchanek and others; The role of upstream mercury loading and speciation on localized and downstream bioaccumulation: A regional assessment of sources and fates of mercury throughout the bay-delta watershed, Applicants: T.H. Suchanek, and others; The status of mercury as a stressor to habitats and species of the San Francisco-Bay delta ecosystem, Applicants: Mark Marvin-DiPasquale, and others; and, Mercury Fluxes in the Cache Creek Watershed: Characterization of mercury speciation and transport from mine wastes, mine drainage and natural sources, Applicants, Jim Rytuba, and others. It is anticipated that information and/or data collected in this program will be freely shared by applicants involved in these other programs.

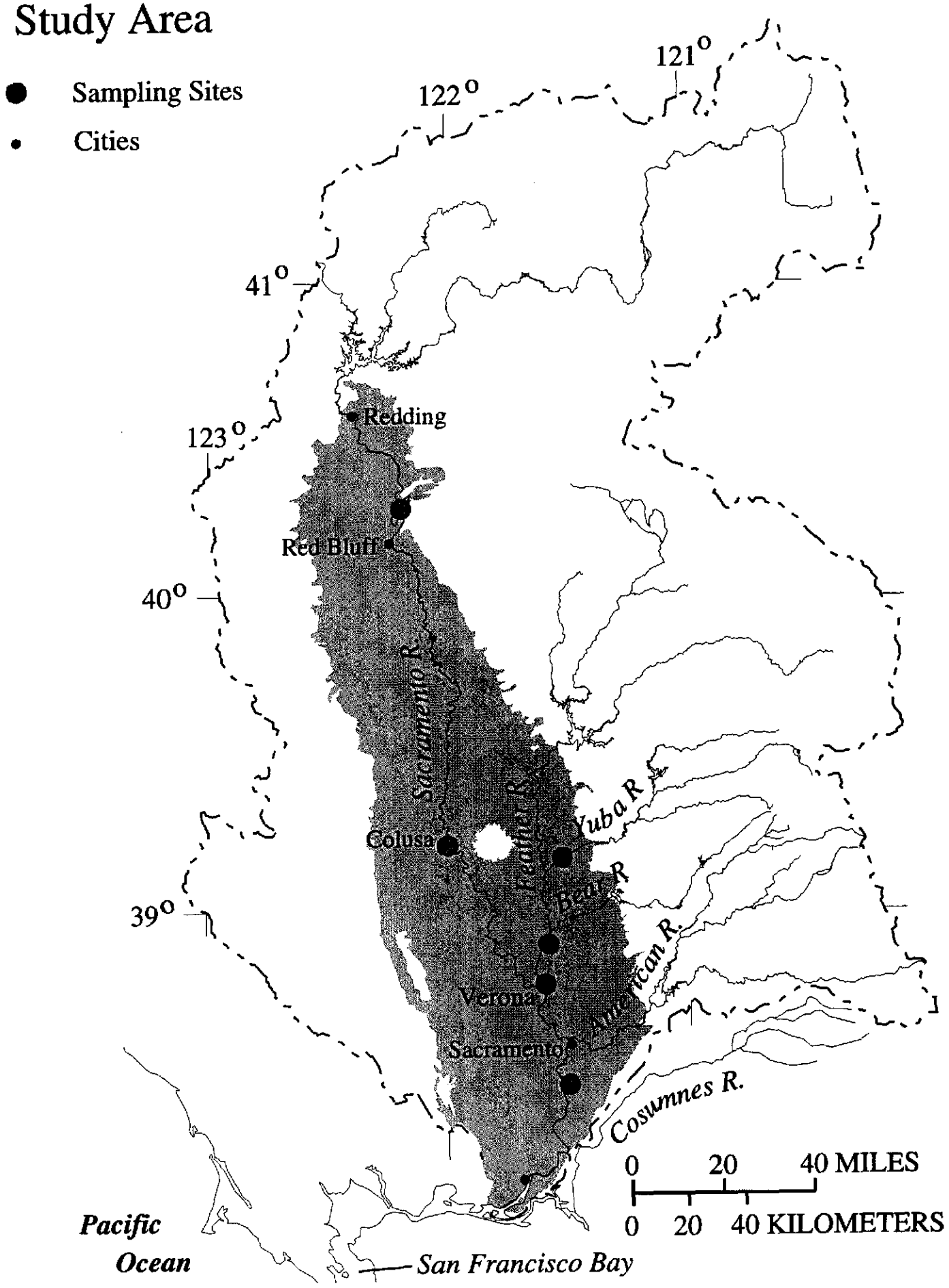
Localization and Characterization of Mercury Sources in Water, Colloids and Sediment in the Sacramento River Between Bend Bridge and Colusa, the Cosumnes River, and the Feather-Yuba-Bear River System

Applicants: Charles Alpers (USGS), Joseph Domagalski (USGS), Howard Taylor (USGS), David Krabbenhoft, David Roth (USGS) and Jim Rytuba (USGS)

Submitted by
Water Resources Division, California District
United States Geologic Survey
Placer Hall
6000 J Street
Sacramento, California 95819-6129

PRIMARY CONTACT: JOSEPH DOMAGALSKI (USGS) 916 278 3077, joed@usgs.gov

Study Area



I-006164

Project Description

a. Project Description and Approach

Any attempts to manage the input of mercury to the San Francisco Bay and Delta will require detailed knowledge of the sources of that mercury, and the chemical forms that it resides in. It will be necessary to understand the temporal and spatial variability in mercury speciation, transport, and loads throughout the Sacramento River and other large tributaries, such as the Cosumnes River. A thorough knowledge of the river system, on a watershed basis, will allow water quality managers to determine what stretches of river are impacted by contaminants such as mercury. To date, there are major gaps in that understanding. Recent work, by consultants to the Sacramento County Regional Sanitation District, and by the U.S. Geological Survey, for example, have shown that anomalies in mercury concentrations can be detected along a large reach of the Sacramento River. That reach of the river is between Red Bluff and Colusa. Storm samplings on two subsequent years by these two groups have shown that the greatest increase in loading occurs somewhere on the Sacramento River between those two sites. This is considered anomalous because there are no known sources of mercury along that 110 mile reach. The increase in loading occurs along a stretch of the river that is above the confluence of the Sacramento River and the Feather River, the latter of which drains a large portion of the former gold mining region where mercury was used extensively in processing gold ores by amalgamation, and also above the confluence of the Sacramento River and two large agricultural drainage systems--Colusa Basin Drain and Sacramento Slough. Identification of the sources of the mercury contributing to those observed high concentrations will lead to subsequent investigations to determine possible remediation and/or clean-up options.

In addition to characterizing these local sources of mercury to the Sacramento River, it is also critical to understand where, when, and how methylation of mercury occurs. Methyl mercury is an organo-metallic compound which can readily be assimilated by aquatic organisms. Methyl mercury is the form most likely to bioaccumulate and therefore most likely to impact human health and beneficial uses of the aquatic resources including fisheries. The intake of methyl mercury by humans can have severe health effects. Mercury may enter the Sacramento River and its tributaries in a variety of forms including the sulfide mineral cinnabar (HgS), attached to fine inorganic particles such as hydrous iron or aluminum oxides, attached to naturally occurring organic matter, as elemental mercury, or in other forms. Methylation of those forms will be dependent on reaction rates and features of the environment in which the mercury is found. Elevated levels of methyl mercury are known to occur in wetland environments and can be transported by rivers draining those areas. In addition, levels of methyl mercury can be elevated in rivers following runoff events. In California, other potential sources of methyl mercury might be in dredge tailings which line several large Sacramento River tributaries including the Yuba, Cosumnes, and Bear Rivers.

Recent monitoring for methyl mercury has been completed by the U.S. Geological Survey at six locations within the Sacramento River Watershed. Those sites included three locations on the main stem of the Sacramento River--at Colusa, Verona, and Freeport--and two agricultural drains--Colusa Basin Drain near Knights Landing and Sacramento Slough near Knights Landing. Results of that work showed that, on a yearly basis, median concentrations of methyl mercury at those sites are statistically similar at levels that approach concentrations that would be cause for concern, but that larger and more significant concentrations occur following storm-water runoff.

At present, little is known about the transport of methyl mercury from sites downstream of large placer-type gold mining operations, such as the Yuba, Bear and Cosumnes River.

It is proposed that a two year study be completed of mercury concentrations and loads at the following sites: the Sacramento River at Bend Bridge, at Colusa, at Verona, and at Freeport; at the Feather River near Nicolaus; the Yuba River near Marysville and an additional site on the Yuba near dredge tailings; at two similarly chosen sites on the Bear River; and at two similarly chosen sites on the Cosumnes River. In addition, to the sampling at these fixed sites, a single sampling event, during a high flow period, will take place to assess the potential sources of mercury to the Sacramento River between Red Bluff and Colusa. That sampling will consist of close interval sampling, every one or two river miles, for total mercury. Monthly sampling of total and filtered water samples, at the fixed sites, for mercury and methyl mercury is proposed for a period of two years and in addition, it is proposed that detailed geochemical characterization of the mercury be completed seasonally, across a range of flow or hydrologic conditions including storm-water runoff events. That characterization will involve the collection of suitable volumes of water for determination of mercury concentrations in colloidal form, in conventionally filtered water samples (0.45 micrometer filtered), and in samples filtered through a much finer ultra-filter (0.005 micrometer). The latter would provide information on the amount of mercury most likely to be transported in dissolved form. Both mercury and methyl mercury will be measured in these fractionated samples. Further characterization of the mercury in the colloidal forms will include a set of sequential extractions to further determine the specific type of mineralogical species associated with the mercury. Sequential extractions is a process by which the colloids or sediments are placed in solutions that dissolve specific types of minerals while leaving others undissolved. It is the primary way that mineralogic residence of trace elements is determined and has been used successfully in many previous studies, including some completed by the applicants. The results of the sequential extraction studies will be critical in determining the potential for bioavailability of that mercury. Further studies on these colloid concentrates will include a determination of the type of oxide phases, iron or aluminum, and the role of natural organic matter in the transport of the mercury and methyl mercury. The study of the interactions of oxide phases and natural organic matter will be completed using EXAFS technology at Stanford University.

Mercury methylation and transport from dredge sites will be completed by selecting sites along two rivers known to have extensive remnant tailings from previous placer mining operations--the Bear and Cosumnes River. A thorough investigation of suitable sites will be undertaken and two sites wil be chosen at each of these rivers. Sediment samples will be collected and analyzed for mercury and methyl mercury. Monthly sampling at locations above and below will be completed for total mercury and methyl mercury. Sequential extractions will also be completed on those sediments in order to better understand the processes controlling sorption, methylation, and ultimately the transport of the mercury onto those sediments. The sequential extraction experiments will also provide some important information on the bioavailability of the mercury.

Ancillary data collected in this study will be the concentrations of mercury and methyl mercury in river bed sediment at all sites. It is proposed that a collection of this material be completed once in each year of the study. In addition, major element chemistry, nutrient chemistry, the concentrations of total suspended sediment and its size fractions, and the amount of dissolved and suspended organic carbon will be measured in each sampling event. That information will be critical in the determination of geochemical controls on the mercury speciation

and in geochemical modeling exercises. Therefore, a thorough understanding of the major element chemistry is crucial to the success of this project.

b. Location and/or geographic boundaries of project: The project covers an approximate 200 mile reach of the Sacramento River from Red Bluff to Freeport and a portion of the Cosumnes River, as it flows into the Delta. The counties involved in the study are Tehama, Glenn, Butte, Colusa, Sutter, Yuba, Sacramento, and Yolo.

c. Expected benefits: The project will have numerous benefits, especially the applicability of the data generated to aid management decisions for mercury remediation within the Sacramento River/Delta/San Francisco Bay system. In particular, previously uncharacterized sources of mercury currently contributing to the yearly mass loading to the Sacramento River will be characterized. Secondly, further information will be gained on the spatial and temporal variability in the amounts of methyl mercury generated in a major part of the Sacramento River watershed. This will add to the current body of knowledge being generated by the Sacramento River National Water Quality Assessment Program, and will in itself be invaluable in making future decisions on potential remediation. Thirdly, detailed knowledge will be gained on the speciation of the mercury along this major reach of the Sacramento River and information on the potential bioavailability of mercury at each of these locations will be crucial in formulating decisions on which potential remediation sites will best be suited for reducing the harmful biological effects currently being caused by the presence of mercury in these waterways.

d. Background and Biological/Technical Justification: Mercury is currently causing serious water quality problems in the Sacramento River and at downstream locations in the Delta and San Francisco Bay in both tidal and freshwater marsh environments. In particular, bioaccumulation of mercury results in elevated levels in fish tissue, including Green Sturgeon, and Largemouth Bass, which in turn results in advisories against consumption, especially for pregnant women and children. Recent work by consultants to the Sacramento Regional County Sanitation District (SRCSD) has suggested that mercury levels are above those set for protection of aquatic life up to 25% of the year, mostly during the rainy season. In addition, recent work commissioned by the SRCSD and confirmed by the U.S. Geological Survey has shown that the mass loading of mercury, during storm events, is principally derived from uncharacterized and as yet unknown sources. Compounding the problem is that the forms of mercury being introduced to the environment have also not been completely characterized. Some forms of mercury may be recalcitrant and therefore not biologically available, yet other forms, even though introduced in smaller amounts, may in fact be more responsible for the observed bioaccumulation. Therefore, water quality managers are in need of accurate information on the location of mercury sources to these waterways, the forms of that mercury, the potential for the mercury introduced to the environment to bioaccmulate, and the best potential locations for remediation. Currently, insufficient information has been accumulated to make rational decisions on these matters. This project will significantly contribute to the body of knowledge necessary to make these important decisions.

e. Proposed Scope of Work: The scope of work is as follows:
TASK1: The first task will be to examine mercury sources along a reach of the Sacramento River from Red Bluff to Colusa by collecting close interval samples (every one to two river miles) during a storm event. The task will be completed by collecting samples from a boat while following the same parcel of water. In this way, changes in mercury concentration can be readily

detected. This approach has been used successfully in the Mississippi River by one of the applicants (Dr. Howard Taylor).

TASK2: The second task is to complete a spatial and temporal characterization of the amounts of mercury concentrations and loadings and methyl mercury concentrations and loads along a reach of the Sacramento River from Red Bluff to Freeport, and at two major tributaries--the Feather River and the Yuba River. The sites chosen on the Sacramento River are the following: at Bend Bridge, at Colusa, at Verona, and at Freeport. The Feather River site is near Nicolaus, and the Yuba River site is at Marysville. These sites are chosen as to be above and below drainage from previous gold mining operations and to be above and below agricultural drainage. The Feather River and Yuba River carry drainage from previous gold mining regions. Samples will be collected monthly for a period of two years in order to adequately characterize the spatial and temporal variability in mercury and methyl mercury concentrations along this reach of river and during a variety of flow conditions.

TASK3: The third task is to examine the role of dredge tailings, from previous placer gold mining operations as a potential source of methyl mercury formation. The rivers chosen for investigation under the third task are the Bear River, and the Cosumnes River. That task will be completed by measuring the amount of mercury and methyl mercury in the tailings and by collecting water samples above and below the tailings and measuring the amounts of total mercury and methyl mercury. Those collections will be done on a monthly basis, for a period of two years, so that temporal variability in mercury methylation can be assessed across a range of flow conditions. The dredge tailings will also be studied with sequential extraction techniques in order to better understand the mineralogic residence of the mercury in those sediments. That work will help to determine the processes controlling transport of the mercury, its potential bioavailbility, and also the potential or suitability for remediation.

TASK4: A fourth task is to complete detailed characterizations of the speciation of the mercury in various size fractions from water samples and to determine the potential for bioavailability from sequential extraction experiments. Large volume water samples will be fractionated into whole water samples, conventionally filtered samples (0.45 micrometer), ultra-filtered (0.005 micrometers), and colloidal concentrates. The colloidal concentrates will be collected from volumes of water ranging from 100 to 300 or more liters depending on the amount of sediment in the water. Mercury will be measured in the colloidal concentrates and the sequential extraction experiments will be completed on the colloids. The sequential extraction experiments are useful for determing the likely or most abundant mineralogic phases with which the mercury is in and is also useful for determining bioavailability. One of the applicants (Dr. Joseph Domagalski) has had extensive experience with this methodology. The sites chosen for the fourth task are the same as those of the second task

TASK5: The fifth and final task is the sharing of this information with other CALFED participants and through a set of detailed scientific or management reports.

f. MONITORING AND DATA EVALUATION: This project will require the extensive collection of water quality and sediment samples and therefore the collection of new data. Because of this extensive collection of new data, one of the first tasks of the project will be the preparation of a detailed quality assurance/quality control plan. The plan will be written by project scientists and then submitted to a technical advisory committee (TAC) for review, revision, and subsequent approval. Quarterly reports will be available on the data collected and on the results of the quality assurance monitoring.

g. Implementability: The project is in an excellent position for implementability given that all of the major equipment necessary has been purchased from other projects, a mobile laboratory has

already been obtained previously and is currently in use from a preceding project and that mobile lab will be fully available for this project. Finally, a trained technical support staff exists for the implentation.

IV. COSTS AND SCHEDULE TO IMPLEMENT PROPOSED PROJECT:

a. BUDGET COSTS:

A budget sheet for this proposal is shown on the next page.

Task 1	Red Bluff to Colusa mercury synoptic						
		Year 1 (Dec. 1998 through March, 1999)					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct costs)	Service Contracts	Material & Acquisition Contracts	Misc. & other Direct Costs	Total Cost
CALFED	1060	$34,660.00	$56,745.00	$0.00	$0.00	$23,700.00	$115,105.00
USGS Match	0	$0.00	$0.00				$0.00
Total - Task 1	1060	$34,660.00	$56,745.00	$0.00	$0.00	$23,700.00	$115,105.00
Task 2	Spatial and temporal variability in mercury and methyl mercury occurrence						
		Years 1&2 June 1998 through June 2000					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct costs)	Service Contracts	Material & Acquisition Contracts	Misc. & other Direct Costs	Total Cost
CALFED	7176	$208,088.00	$421,525.57	$0.00	$0.00	$250,772.00	$880,385.57
USGS Match	600	$18,000.00	$18,000.00				$36,000.00
USGS-in-kind	400	$18,000.00	$42,000.00			$24,000.00	$84,000.00
Total - Task 2	7776	$226,088.00	$439,525.57	$0.00	$0.00	$250,772.00	$1,000,385.57
Task 3	Examination of mercury and methylation in dredge tailings						
		Years 1&2 June 1998 through June 2000					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct costs)	Service Contracts	Material & Acquisition Contracts	Misc. & other Direct Costs	Total Cost
CALFED	4400	$117,600.00	$227,025.24	$0.00		$169,428.84	$514,054.08
USGS Match	300	$9,000.00	$9,000.00			$0.00	$18,000.00
USGS-in kind	400	$18,000.00	$23,000.00			$5,000.00	$46,000.00
Total - Task 3	0	$0.00	$0.00	$0.00	$0.00	$174,428.84	$578,054.08
Task 4	Mercury fractionation and speciation						
		Years 1&2 June 1998 through June 2000					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct costs)	Service Contracts	Material & Acquisition Contracts	Misc. & other Direct Costs	Total Cost
CALFED	4000	$118,400.00	$257,931.82			$154,257.92	$530,589.74
USGS Match	300	$9,000.00	$9,000.00			$0.00	$18,000.00
USGS-in kind	400	$18,000.00	$25,000.00			$7,000.00	$50,000.00
Total - Task 4	4700	$145,400.00	$291,931.82	$0.00	$0.00	$161,257.92	$598,589.74
Task 5	Report Writing						
		Year 3, October 2000 through September 2001					
	Direct Labor hours	Direct Salary and benefits	Overhead (on all direct	Service Contracts	Material & Acquisition	Misc. & other	Total Cost
CALFED	2600	$84,600.00	$108,600.00			$24,000.00	$217,200.00
USGS Match	300	$9,000.00	$9,000.00			$0.00	$18,000.00
USGS-in kind	400	$18,000.00	$18,000.00			$0.00	$36,000.00
Total - Task 5	3300	$111,600.00	$135,600.00	$0.00	$0.00	$24,000.00	$271,200.00
Totals, Tasks 1-5							
CALFED	16636	$478,748.00	$963,227.63	$0.00	$0.00	$598,158.76	$2,257,334.39
USGS	1500	$45,000.00	$45,000.00	$0.00	$0.00	$0.00	$90,000.00
USGS-in kind	800	36000	48000	0	0	12000	$180,000.00

b. SCHEDULE MILESTONES: The first task will be completed by January or February, 1999, depending on meteorological conditions. The second, third, and fourth tasks begin in June 1998 will be completed by June, 2000. The fifth task will be completed by September 2001.

c. THIRD PARTY IMPACTS: There are no third party impacts.

V. APPLICANT QUALIFICATIONS:

Dr. Domagalski will supervise the collection of all water samples, sediment samples, and colloid concentrates. Dr. Alpers will supervise the geochemical characterization of those samples. Dr. Howard Taylor and Dr. Roth will have primary responsibility for the analytical chemistry of the fractionated water samples and sediments. Dr. Krabbenhoft will supervise the studies of methyl mercury, will provide the methyl mercury analyses, and will assist in the interpretation of methyl mercury occurrence and geochemistry. Dr. Rytuba will serve as senior geologist for the project. All applicants will assist in the preparation of the final report.

>Dr. Charles N. Alpers received a Ph.D. in geochemistry from the University of California, Berkeley in 1986, and has been involved in numerous water-quality investigations involving trace-element geochemistry and the transport of trace elements in surface and ground water systems. In his work with the U.S. Geological Survey since 1987, Dr. Alpers has investigated the Penn Mine acid mine drainage system, has completed extensive investigations of acid mine drainage from the Iron Mountain Superfund site, and is actively involved in characterizing the geochemistry of trace elements, including mercury, in the Sacramento River along a reach of the river between Shasta Lake and Freeport.
>Dr. Alpers is a member of several technical advisory committees involved with the remediation of inactive and abandoned mine sites in California and other states, and has published extensively on the topics of the environmental geochemistry of sulfide oxidation (e.g. Alpers and Blowes, 1994; Nordstrom and Alpers, 1995, 1997)
>ground-water characterization at mine sites (e.g. Hamlin and Alpers, 1995, 1996),
>and the effects of efflorescent salts on mine drainage composition (Alpers et al., 1994a, 1994b; Alpers and Nordstrom, 1997).

Dr. Joseph Domagalski has a Ph.D. from the Johns Hopkins University and has been associated with the U.S. Geological Survey since 1988. He currently is Project Chief for the Sacramento River Basin National Water Quality Assessment (NAWQA) Program. His professional experience has included characterizations of trace metal chemistry in closed-basin lakes of the western United States, characterizations of pesticide occurrence in surface and ground water of the Central Valley of California as well as within the San Francisco Bay estuary, and more recently, with the adaptation of National Water Quality Assessment Program protocols or study design for the study of trace metals, including mercury. As part of the NAWQA program, a modern mobile laboratory was outfitted for trace metal and other water sample collection and will be fully available for use in this project. In addition, Dr. Domagalski supervises a trained staff of water quality technicians who have several years of clean method/protocol sampling techniques. There are three technicians qualified to be team leaders for sampling events.

>Dr. Howard Taylor is a senior geochemist and analytical chemist for the U.S. Geological Survey with over 25 years of investigations of trace metal chemistry in large river and ground water systems throughout the United States. Dr. Taylor is a senior scientist on the comprehensive USGS

study of trace metals in the Mississippi River system that began in 1987 (Garbarino et al., 1996), and during 1996-1997 has been providing the analytical chemistry support for a study of trace metal transport in the upper Sacramento River Basin. Dr. Taylor has performed pioneering development work in field sampling and processing and the laboratory technology of the determination of ultra-low concentration levels of trace metals, including mercury, in environmental applications.

Dr. David Krabbenhoft is a senior hydrologist with the U.S. Geological Survey, based in Madison, Wisconsin, who operates a mercury and methyl mercury laboratory and who has been involved with detailed research projects on mercury speciation and methylation in several locations including the Florida Everglades. Dr. Krabbenhoft is the senior author on several publications on mercury and methyl mercury chemistry. He has been involved with mercury studies in California and has collaborated with Dr. Domagalski in the design and incorporation of mercury studies to the Sacramento River Basin National Water Quality Assessment Program.

>Dr. David Roth received his Ph.D. in 1994 from Colorado State University; his dissertation work involved ultratrace analysis of mercury in environmental samples. Dr. Roth is a frequent collaborator with Dr. Howard Taylor on mercury studies (e.g. Roth et al., 1996; Roth and Taylor, 1995, 1997).
>Dr. Roth has been involved with both Dr. Alpers and Dr. Domagalski in the preparation and isolation of colloidal material from the Sacramento River and its subsequent geochemical interpretation. Dr. Roth is currently analyzing numerous samples from the Sacramento River for trace metals and mercury as part of the Sacramento River trace metals transport project.

>Dr. James J. Rutuba is a senior geologist with the Geologic Division of the USGS. Dr. Rytuba is an internationally known expert on the geology and geochemistry of the types of mercury deposits located in the Coast Ranges. Dr. Rytuba has been extremely active in adapting classic and novel geologic and geochemical techniques for environmental characterization.

SELECTED REFERENCES

>Alpers, C.N., Nordstrom, D.K., and Thompson, J.M., 1994, Seasonal variations in the Zn/Cu ratio of acid mine drainage from Iron Mountain, California; in Environmental Geochemistry of Sulfide Oxidation: Alpers, C.N. and Blowes, D.W. (eds.), American Chemical Society, Washington D.C., ACS Symposium Series, v. 550, p. 324-344

>Alpers, C.N. and Blowes, D.W. (eds.), 1994, Environmental Geochemistry of Sulfide Oxidation: American Chemical Society, Washington D.C., ACS Symposium Series, v. 550, 681 p.

>Alpers, C.N., Blowes, D.W., Nordstrom, D.K., and Jambor, J.L., 1994, Secondary minerals and acid mine-water chemistry; in Environmental Geochemistry of Sulfide Mine-Wastes: Jambor, J.L., and Blowes, D.W. (eds.), Mineralogical Association of Canada, Short Course Notes, v. 22, Nepean, Ontario, p. 247-270.

>Hamlin, S.N., and Alpers, C.N., 1995, Hydrogeology and Geochemistry of Acid Mine Drainage in Ground Water in the Vicinity of Penn Mine and Camanche Reservoir, Calaveras County, California--First- Year Summary: U.S. Geological Survey Water-Resources Investigations Report

94-4040, 45 p. (I was responsible for study design, and I contributed to all parts of report, especially geochemical interpretations).

>Nordstrom, D.K., and Alpers, C.N., 1995, Remedial investigations, decisions, and geochemical consequences at Iron Mountain Mine, California: Proceedings of Sudbury '95 - Mining and the Environment, Hynes, T.P., and Blanchette, M.C. (eds.), May 28 - June 1, 1995, Sudbury, Ontario, Canada, CANMET, Ottawa. v. 2, p. 633-642. (I contributed to all aspects of the research including field, laboratory, and computer modeling.)

>Hamlin, S.N., and Alpers, C.N., 1996, Hydrogeology and Geochemistry of Acid Mine Drainage in Ground Water in the Vicinity of Penn Mine and Camanche Reservoir, Calaveras County, California: Second-Year Summary, 1992-93: U.S. Geological Survey Water Resources Investigations Report 96-4257, 44 p.

>Alpers, C.N., and Nordstrom, D.K., 1997 (in press), Geochemical modeling of water-rock interactions in mining environments; in The Environmental Geochemistry of Mineral Deposits. Part A. Processes, Methods, and Health Issues: Plumlee, G.S., and Logsdon, M.J. (eds.) Society of Economic Geologists, Reviews in Economic Geology, v. 6, chapter 14, 35 p.

>Nordstrom, D.K., and Alpers, C.N., 1997 (in press), Geochemistry of acid mine waters; in The Environmental Geochemistry of Mineral Deposits. Part A. Processes, Methods, and Health Issues: Plumlee, G.S., and Logsdon, M.J. (eds.), Society of Economic Geologists, Reviews in Economic Geology, v. 6, chapter 6, 28 p.

Garbarino, J.R., Hayes, H.C., Roth, D.A., Antweiler, R.C., Brinton, T.I., and H.E. Taylor (1996) Heavy metals in the Mississippi river, in R.H. Meade and J.A. Leenheer (editors) Contaminants in the Mississippi River, 1987-1992, U.S. Geological Survey, Circular 1133.

VI. Compliance with standard terms and conditions

The USGS is in compliance with all specified terms and conditions with exception of item 9 of Attachment D of the RFP. Federal law pertinent to this item is as follows:

The USGS agrees to cooperate to the extent allowed by federal law, in submittal of all claims for alleged loss, injuries, or damage to persons or property arising from the acts of USGS employees, agents, subcontractors, or assigns, acting within the scope of their employment in connection with the performance of this agreement, pursuant to the Federal Tort Claims Act (28 U.S.C. &2671, et seq.).

This federal requirement has not been an obstacle in the past, as evidenced by our approximately 10 million dollars in cooperative agreements with numerous state and other public agencies that we entered in federal fiscal year 1998.

Item 8

NONDISCRIMINATION COMPLIANCE STATEMENT

COMPANY NAME

U.S. Geological Survey

The company named above (hereinafter referred to as "prospective contractor") hereby certifies, unles specifically exempted, compliance with Government Code Section 12990 (a-f) and California Code o Regulations, Title 2, Division 4, Chapter 5 in matters relating to reporting requirements and th development, implementation and maintenance of a Nondiscrimination Program. Prospective contracto agrees not to unlawfully discriminate, harass or allow harassment against any employee or applicant fo employment because of sex, race, color, ancestry, religious creed, national origin, disability (includin HIV and AIDS), medical condition (cancer), age, marital status, denial of family and medical care leav and denial of pregnancy disability leave.

CERTIFICATION

I, the official named below, hereby swear that I am duly authorized to legally bind the prospectiv contractor to the above described certification. I am fully aware that this certification, executed on th date and in the county below, is made under penalty of perjury under the laws of the State of Californi

OFFICIAL'S NAME

Michael V. Shulters

DATE EXECUTED

July 25, 1997

EXECUTED IN THE COUNTY OF

Sacramento, California

PROSPECTIVE CONTRACTOR'S SIGNATURE

R Fogelman

PROSPECTIVE CONTRACTOR'S TITLE

for District Chief

PROSPECTIVE CONTRACTOR'S LEGAL BUSINESS NAME

U.S. Geological Survey